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ABSTRACT

The concept of the personal computer (PC) as a stand-alone, single-user computer has had its day. The 8-bit processors cannot support the newer applications, and, although there have been some advances in 16-bit microprocessors, the "second generation" software is immature and does not work well. The immediate problem for colleges and universities is how to replace and/or upgrade their obsolete computing equipment. The trend is toward 32-bit PCs and connecting, sharing databases, and linking departments. The "age of the peripherals" is beginning, and add-ons will include 640K RAM, enhanced graphic boards, laser printers, local area networks, high-resolution graphics monitors, fixed disks, hard disk boards, and CD-ROM players. Future enhancements to existing PC DOS operating systems will incorporate multi-tasking, which will allow users to run a variety of applications simultaneously. The evolution from 16-bit to 32-bit technology will enable users to protect their investment in hardware and software, and software will take full advantage of increased memory, storage, and multi-tasking capabilities. The PC of the future will have to be a strategic education tool for learning. It must be able to program major languages; be capable of accessing library databases; be a remote, online tutorial unit; be able to download instructional databases to fixed disk storage or a CD-ROM device; be a terminal for electronic mail, class assignments, and campus news; be an efficient word processor with a full keyboard; and have graphics-based software and sound/voice capabilities. Advanced versions of the laptop computer will be especially important for student use. (DJR)

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ROLE OF COLLEGES IN THE COMING DEMISE OF THE PERSONAL COMPUTER INDUSTRY

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1. Introduction

The demise of personal computers is like a "death summons" of current technology. The extinction of the 8-bit and 16-bit microprocessor systems is our first priority, but we also must look to the future for hardware and software development. You might say to me, "Don't mourn for the personal computer industry--it's merely growing up!" That may be too easy. I know when we talk with a neighbor of an older person who has died, "He had a good life; he made his contribution to life; there was no need to keep him on life support, it was his time to die." If you have a personal computer, you naturally want to keep it going with new software, but there comes a time when you have to pull the plug, so to speak. My 1978 Appl II+, for several years, ran with 1.1 version of VisiCalc and 3.2 DOS; it performed well with Wordstar and dBase II under CP/M; and with VisiPlot there were color graphics, and back in 1981, after depreciation, I gave this machine to my sister who enjoys adventure games like "Wizard and the Princess."

The concept of the personal computer as a standalone, single-user computer, "my computer" system--has had its day. Our postmortem will give us something to cheer about; in any event, we need to carry on as well as to anticipate the campus computing requirements.

2. PC Tombstones

American homes and educational institutions are filled with a wide variety of dead machines: Apples, Ataris, TRS-80s, Commodores, TIs, and IBM PC Jrs. Atari Corporation saw

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the collapse of its video game business in 1983 and home computer sales in 1984. According to Future Computing, new sales of personal computers to the home market are almost nonexistent and retailers had little profit to show in 1985.

Business and government offices have their share of obsolete personal computers like the Osborne Portable, Apple III, DEC Rainbow, Computer Dot Devices, Columbia, Eagle, and a number of other IBM PC compatible models. Corporate use of microcomputers can have a highly variable effect of certain machines, e.g., IBM PC XT will be replaced by the IBM PC AT.

2.1 8-Bit Micro Replacements

Clearly the 8-bit processors (8080, Z-80, and 6502) have had their day and these classic devices (from 1975) cannot support the newer applications. In more recent years (since 1981), there were some advances in 16-bit microprocessors, and we can see the increased use of IBM PCs with larger RAM memories and fixed disk drives. It is also evident that Microsoft, IBM, and others are not doing very well with windows, multi-tasking, multi-programming, and networking. The "second generation" software (PC DOS 1.1, 2.0, 2.1, 3.0 and 3.1) is immature and really does not work very well.

One immediate problem in colleges and universities is how to replace the 8-bit Apples, TRS-80s, and Commodores and/or upgrade the IBM PC machines. A professor at a Pennsylvania College recently commented in PC Magazine (December 10, 1985, p. 140); "many colleges are stuck with obsolete computing equipment and a tight budget that prevents them from keeping up with current trends. Most of them are about 3 to 5 years behind the times."

Consider the present lack of educational value in these obsolete, 8-bit machines and their software; do students need spreadsheets in their liberal arts courses; can graphic programs be used in any course; do micro data bases work well in the humanities; and how much programming does a history major do? By default, we have the word processing benefit which is less than adequate on Commodores, Atari, Apples, and TRS computers; even with the most popular and one of the simplest word processing systems, Bank Street Writer for example, a first time Apple IIe or IIc user must spend several hours to learn the skills necessary to write a short essay. We

should forget forever Wordstar and its control commands, Applewriter II with its keystrokers, and the other 200-word processing programs for the Apple II+/IIe computers.

Remember, it was Apple with their new wave computer philosophy that encouraged the expansion of personal freedom and opened up new areas of human potential; but it was IBM that saw the PC as a tool to solve a business problem. When faculty and administrators tell me they are not using their Apples at home any more, I inquire about word processing; they tell me it is easier not to be bothered. I think we have most of the reasons why the faculty and the rest of Americans are not really using their 8-bit personal computers.

An evaluation of personal computers on campus suggests the demise in 8- as well as 16-bit PC machines. Within three years, large numbers of students will be buying 32-bit PCs, not unlike the first wave Apple Macintosh machines now in use.

Will the faculty, the library, the academic computer center, and administration be ready? The PC communications demand can be significant. DP managers are now influencing PC decisions and have the right idea that PCs must connect, sharing data bases and linking departments. If the PC industry is to progress, it has to cease being a personal computer industry. IBM's token-ring protocol network will push this PC industry forward. It will give software vendors a path to follow. General Electric's Dealertalk and Cullinet's Information Data Base also show how micro-to-mainframe communications can be achieved by any user, if the interface is good.

Colleges and universities by 1990 will be facing the PC integration with the curriculum. Traditional mainframes are roughly in the position of the dinosaurs after a large meteor hit the earth some 60 million years ago. The next generation of PCs (PC IIs) will become the protomammals of the future. Knowing the present day problems and realizing our legacy of out-of-date hardware as well as software not written, we can more readily understand the problems with a new generation of PCs.

3. Advancing the IBM PC

New personal computers like the IBM PC AT (80286) are

becoming faster and cheaper, but colleges are not necessarily rushing to purchase them. There are thousands of IBM PCs or compatibles in universities. Faculty and staff are using these machines for teaching word processing or programming languages, but developing an application like graphics usually requires more hardware resources. Most certainly, for a couple of years, these 8088-based or 16-bit PCs, with significant enhancements, will be able to run up-to-date software, e.g., windows, graphics-based software, and database applications. If colleges want to implement for example, the updated SPSS/PC+, they will need an IBM PC XT or PC AT with a minimum of 384K of RAM, a 10-megabyte hard disk, and a coprocessor 8087.

3.1 Age of the Peripheral

We are beginning an "age of the peripheral." The average PC today is much different than it was in November 1981 (IBM DOS 1.0 with 64K). PC machines with 512K of RAM memory and a 10 MB fixed disk drive are commonplace; the abundance of fully loaded PCs reflects the tumbling price of memory.

Small fixed disk drives three years ago cost almost $6,000; now mail-order outlets sell a 20-megabyte drive for $400. These reduced prices have little to do with the technological advances or better manufacturing techniques (the factors that usually cause computer prices to decline); rather, the oversupply has vastly outstripped the demand. Manufacturers estimated production lines in the mistaken anticipation that early 1984 order rates for personal computers would continue to grow.

In this age of peripherals, the add-ons will certainly include: 640K RAM, above boards, enhanced graphic boards, laser printers, local area networks, high-resolution graphics monitors, fixed disks, hard disk boards, and CD-ROM (compact-disk ready-only memory) players.

Colleges surely believe in this PC age "it's nice to learn from your mistakes, but it's even nicer to learn from the mistakes of others." The most common mistake is purchasing a microcomputer system that you'll end up wanting to replace, rather than upgrade, in three years. At the present time, it is much easier to upgrade an obsolete IBM PC or XT model than any other small computer available. There can be substantial performance and price advantage achieved by buying selected non-IBM add-ons to the campus

inventories. The difficulty, of course, is finding one to select. For example, there are probably over a hundred add-on fixed disk combinations to choose from, with varying degrees of dependability and compatibility. The key issue to be addressed by add-on computer buyers is, "How does the price and performance compare with either upgrading the IBM PC or buying a new XT or AT system?"

Want more computer graphics on campus without a MAC? Anyone using a PC with a monochrome screen can upgrade to a Hercules Graphics Card or its equivalent. If RGB color is available, IBM's Enhanced Graphic Adapter (EGA) is the board of choice. It is too bad that IBM is just now implementing the PC graphics interface, and having to buy a graphics card for the PC is ridiculous. A major challenge for colleges will be devising ways to get today's software to run on the IBM PC class of computers without adding 512K of RAM, EGA, and high-resolution monitors, multimegabytes of fixed disk drives, and laser printers. Within 24 months, these PCs and new peripherals will be unable to use the multitasking software; our current IBM PCs will appear to be obsolete to students and their parents.

In 1985, software outstripped the capacity of the hardware; this will be reversed in the years ahead. The new micros will equal and in some cases exceed the power of most minicomputers. This power at our fingertips should break today's hardware bottlenecks. Existing efforts to squeeze 16-bit machine efficiency will cease and we will move ahead with the new technology.

4. PC/MS DOS Evolution

For the most part, there will be evolution, not revolution, within existing PC DOS operating systems. Future PC DOS enhancements will incorporate multitasking which will allow users to run a variety of applications simultaneously. The key attraction of multitasking is that it will allow users to quickly move from one task to another.

Windowing environments (IBM's Topview and Microsoft's Windows) have not yet proven themselves, and concurrency solutions have focused on a way to bypass the MS Operating System with RAM based products like Ready, Turbo-Lightning, Sidekick, and Superkey; the memory-resident programs are

reaching their peak and they will become less important as PCs have true multitasking. RAM applications reside in the background and are increasingly popular with PC users; two years ago, few people had very little understanding of RAM-resident programs. A RAM-resident program utilizes the terminate-and-stay-resident function in PC/MS DOS which allows it to hold onto the RAM allocation even when the program is not actively being used and has receded into the background more. Because RAM-resident applications provide a form ot multitasking, colleges like other users will learn quickly; for example, it is extremely dangerous to interrupt DOS while writing to disk and some of the public domain software do this. RAM-resident software does not provide concurrency and is only a stopgas measure for multitasking.

The latest version, PC DOS 3.2, will use a version of the UNIX operating system on the IBM PC RI computer. As IBM integrates new (80886 and 801-base) chips into a 32-bit micro environment, PC DOS 4.0 will be both multitasking and have the capability to address more than 640K of RAM. Like UNIX, it will allow users to use the processor in "protected" mode.

Certainly the trend toward more sophisticated PC hardware means that the operating system will become more powerful with a visual interface (user friendly) for a graphics-based machine. Just think of all the things like Autoexec.bat file commands that you have to do to the MS DOS disk; one of the nice things about the Macintosh is that you turn it on, and it's easy from there. The PC industry has not done this, but there are now all kinds of programs to make the junky interface easy-to-use.

5. Back to the Future

The ongoing miracle of VLSI continued in 1984, as Intel released early versions of its 32-bit 80386 microprocessor. AT&T, as well as IBM and Toshiba, began production of the 1-megabit RAM chip.

A year from now, all IBM PCs sold will be 286-based. Within three years, there will be an upgrade to 386-based models. This 32-bit machine's motherboard would contain 1 megabyte of RAM, a full graphics interface, self-contained serial and parallel prots, and have standard 30-begabyte hard disk drives.

The significance of the evolution from 16-bit to 32-bit technology is that users can hope their investment in hardware and software is protected, and they can upgrade systems with less risk. Software, when it appears, will be taking full advantage of increased memory, storage, and multiuser processing capabilities. The microcomputer industry is at the beginning of a major transformation; with the shift from textbased software to graphics-based software, in part to take advantage of advances in new chips, laser printing and networking. In adopting a graphics-interface standard by concensus, applications will be transferable between machines.

There will be software that take full advantage shortly of the IBM PC AT's memory, storage, and multiuser capabilities, but the 32-bit PC (80386-based machines) will be the new catalyst for new software and hardware development. It's going to motivate the industry to develop faster disk drives and other peripherals.

College students may realize the PC's great promise of making information readily available so they can search for, retrieve, and display data in meaningful and timely ways. One influential innovation in the coming years will concern optical disk technology. When the compact disk player first appeared three years ago at $1,000, it was too expensive; but prices have dropped as low as $150.

CD-ROM players use optical recording media to store as much as 560 megabutes of data per disk. There is serious interest in using the CD-ROM players as data retrieval devices for personal computers. There is already an encyclopedia on a Philips disk player and an IBM PC. College students with their computers can have the CD-ROM players for subject reference collections, e.g., chemical abstracts. The future of CD-ROM is very exciting.

6. Requirements for Student PC

By 1990, the Student PC must be more portable than the present transportables like the IBM PC portable, Compaq or even the Macintosh. Professor McFarlan of the Harvard Business School, where the IBM PC portable is being used, is banking on a new personal computer; "What we need is a 6 ½ pound computer with 256 to 512K and high quality screen--not a liquid crystal display. The machine would be battery

powered and could run for up to 4 hours." (PC World, January 1986, p. 158).

Apple Computer has demonstrated with the 32-bit Macintosh machine that there was a market for the personal computer with a capital P; but whatever benefits the MAC offers, it is offset by the disadvantage of not being a standard. The higher education community is moving relentlessly toward IBM; Apple reported a 23% drop in sales this quarter. Every time colleges and universities make a buying decision they have to consider whether to instruct their students on what they will use in the future or what they will never see, and what is easily connected and is fully compatible to the campus mainframe.

There are other signs that the MAC, as it is today, will not be at the head of the 1990 class. One of the latest rages by members of MAC Users Groups is to connect an inexpensive ($300 - $500) laptop computer. I am using NEC PC-8020lA (but I could use a Radio Shack Model 100). Lugging the Mac around is fine for a freshman, but when my arm gets tired or I go where the MAC can't (at the library, in my car, on a plane, or under sail on my boat), I think having a truly portable laptop is the ultimate solution. The MAC just dies more slowly than the earlier personal computers we mentioned.

PC (future) will have to be a strategic education tool for learning. The PC machine must be able to program the major languages; be capable of accessing library databases; be a remote, on-line tutorial unit; capable for classroom work such as programming or spreadsheets; be able to down load instructional databases to fixed disk storage or a CD-ROM device; be a terminal for electric mail, class assignments and campus news; and be an efficient word processor with full keyboard including cursor keys (mouse optional). PC 1990 will be a 32-bit processor with graphics-based software as well as sound/voice capabilities.

6.1 PC Hardware Configuration

LAP MODEL:	IBM and Others in 1990
MPU:	Intel 80386 (80C386)
COPROCESSORS:	Math and Voice Processors
RAM:	1M Minimum (Expandable to 8M)
ROM:	256K to 512K (Operating System Support)

DISK DRIVE:	3.25 (800KB)
FIXED DRIVE:	20 to 50M
CD-ROM:	Optional (560M)
VDT:	Electroluminiscent or Improved Technology
OPERATION SYSTEMS:	UNIX and PC-MS DOS (5.0 Version)
MODEM:	Included
INPUT/OUTPUT:	Parallel and Serial Ports Included

7. Laptop Computing

The personal computers on campus today will truly be outmoded when the PC Lap unit arrives. One way to understand the evolution that will take place is to review the history of the portable computer, and then look at the anticipated growth of the laptop. My earliest feeling for a portable processor was the Hewlett-Packard programmable calculator. It had a tiny LED numeric display for a line of 15 digits and a slot through which you slide a magnetic strip on which you store programs.

7.1 Early Portables

The next milestone was the Osborne portable (1981) which became an overnight best seller. Later in 1981, Epson introduced a laptop, which had a LED display and 16K bytes of memory. Grid delivered, in 1982, an expensive (over $8,000) laptop with an amazing electroluminescent display. In 1983, Radio Shack brought out the Model 100 with an 8-line by 40-column display that was big enough to use for writing. It could take up to 32K bytes of memory and had word processing, communications, and other software stored in ROM. It had serial and parallel ports plus an internal direct-connect modem in order to down load or upload files. It was an instant hit with journalists and other writers, and many newspapers bought them by the dozen for their staffs.

When laptop computers first appeared, the industry predicted rapid growth for the machines, with sales nearly doubling each year. After all, it seemed if calculators and the Sony Walkman had sold so well, who could turn down a battery-operated, briefcase-size micro that could be used while on board an airplane?

Unfortunately for the computer industry, there were overly optimistic market forecasts, sharp price cuts, and bankruptcies for Osborne and others.

7.2 Laptops Today

Despite the laptop computer's unimpressive showing to date, market experts predict that its fortunes will dramatically change in the next few years as IBM "opens the floodgates." By 1987, laptop sales will rebound; and by 1989, about seven million laptops will have been sold, 10 times the number sold to date according to Dataquest. A July report projects that true portables will be the most rapidly growing segment of the PC market through the end of the decade.

Laptop computers presently fall into two broad categories: low-end models and high-end models. The Radio Shack Model 100, Epson, and NEC PC 8401A are typical low-end models. They generally cost between $600 and $1,000.

The high-end models (Data General/One, Quadram Datavue 25, Ericsson Portable PC, Hewlett-Packard Portable Plus, Morrow Pivot II, Panasonic Executive, GRID3, Tandy 600, Visual Computer and Heath ZP 150), run on batteries, have built-in disk drives, and use internal memories equivalent to desktop computers. Most run popular IBM business software like 1-2-3 with modification. They generally cost between $2,000 and $4,000.

Laptop models have been stymied by display problems. A satisfactory display should combine high readability and low power consumption. The best laptop on the market is the version of the Data General/One with an electroluminiscent display. Several Japanese and American Companies are reportedly working furiously on new laptops; the next generation is to arrive in 1987.

It is expected that laptops would run standard, off-the-shelf MS DOS software and offer a battery-powered option, lighter weight, more storage capacity, and most importantly, a truly readable screen. Research in display technology and low-power integrated circuits should finally lead to portable computers that match desktop computers function for function.

7.3 IBM Laptops

IBM is planning to introduce laptop PCs this year. The two machines, which are aimed at different markets, have been shown to selected developers as well as to corporate and U.S. Government accounts. One version of the new IBM Laptop, (code-named P-12), is an option-oriented machine which uses an Intel 80C88 microprocessor, with 256K RAM and a backlit liquid crystal display (LCD) screen, but without a disk drive. This machine is likely to sell for below $1,500; a high-end model (P-14) will have a single 3 ½ inch dual-sided disk drive, 640K or RAM, and an electroluminiscent screen would cost about $2,000. IBM is extremely interested in implementing CMOS versions of the Intel 80286 microprocessor chip for laptop computers.

8. Student Laptops

By 1990, a state-of-the-art, 386-based laptop model by IBM and others will be available. We should expect low-end models (80C86) to be priced in the $150 to $200 range and offer a quieter keyboard; thousands of college students will buy them to take notes in class.

Students will feel that if they don't have a laptop PC, they can't be as productive in their classrooms, lecture halls, at the library, and on their desktops in their dormitories. The cost of the laptops will vary with the processor, RAM memory, and storage options.

At the beginning of the last decade of this century, we can expect a super-small machine with 386-based processor with only ten nonmemory chips, an inexpensive display with 1000 by 1000 pixel resolution. When we have this technology in the next three years, people using word processing software will look at the 640 x 200 we have today and wonder what we were doing in 1985.